

CHAPTER 3

METHODOLOGY RESEACH

The construction of the model of the system on which Automatic Electrical Failure Detection is to be performed is a key element in the electrical system with wireless.

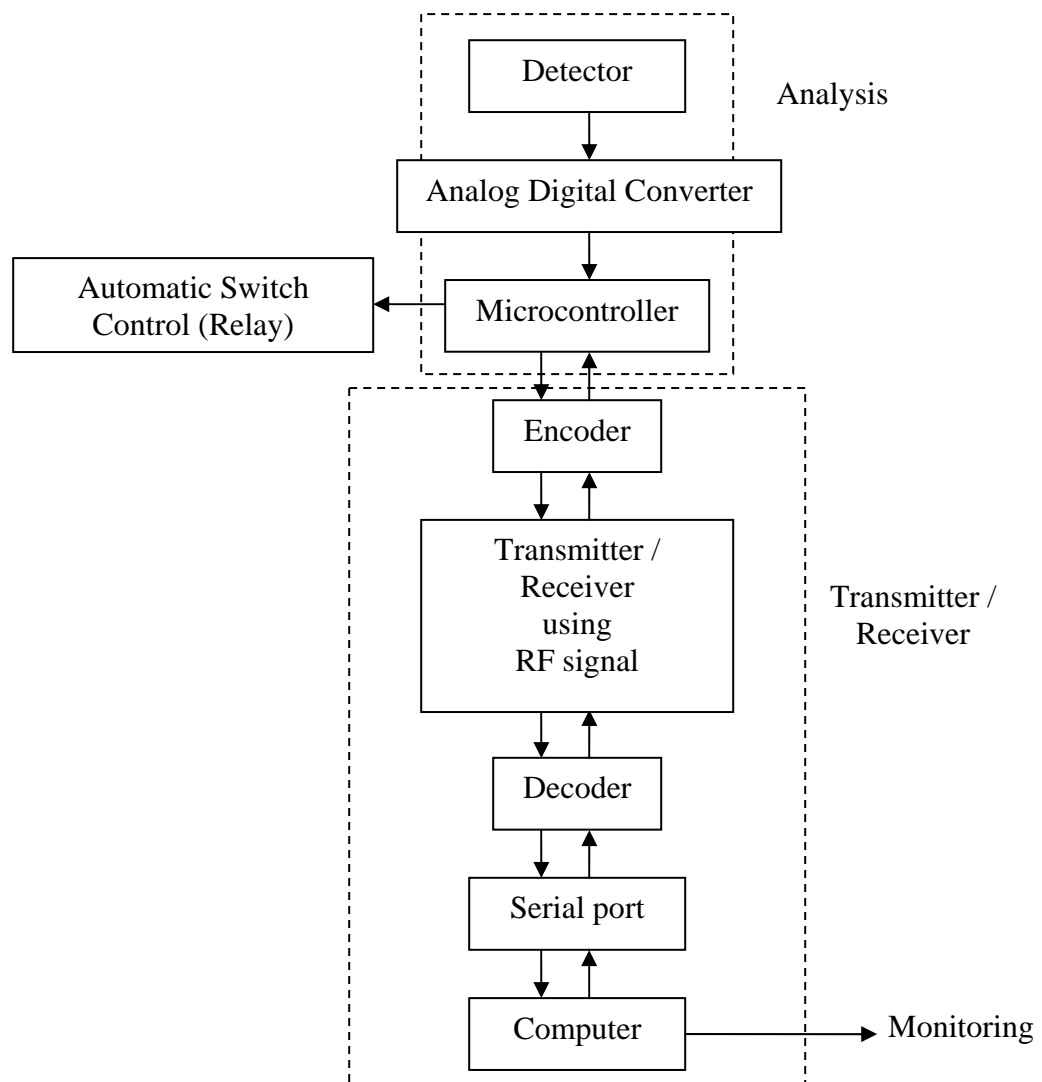


Figure 3.0: Above is the of the overall project architecture.

The model needs to describe the system at three different levels: Analysis, Transmitter and Receiver. The project consists of hardware and software development. The system will be equipped with a function to detect current using sensor and radio frequency (RF) module to transfer data. The RF module is a hardware that connects data transmission between system and computer to the serial port in the RF module.

Literature research is the most important part before start a project. It helps student to understand the overall project going to process, gather the important information that might need for our analysis, conclusion and sharpen the knowledge about what student going to face off. For this project, the literature research will cover 3 parts which includes electrical and electronic knowledge and failure case study where peoples have been published in the conferences likes IEEE conference. The third part will be the hardware and software. This will helps us to search for gain the methods how they done in the similar project and understands how to use the hardware to collect the data.

This project consists of both hardware and software development. The system will be equipped with a function to detect current using sensor, and to the RF module. RF module is a hardware that connects data transmission between system and computer. The communication will go through serial port from computer to the serial port in RF module. There is so much software that can be use. However, Visual Basic 6 has chosen as the main software to monitoring my system.

3.2 Hardware and Components

Hardware is the general term that is used to describe physical artifacts of a technology. It can be equipment such as keys, locks, hinges, latches, corners, handles, wire, chains, plumbing supplies, tools, utensils, cutlery and machine parts, especially when they are made of metal what its call is component. The components have been use in this project are sensor, analog to digital converter, microcontroller, relay and the components can refer from the Figures 3.2 to Figure 3.6.

3.1.1 Detector (Hall Effect sensor- LTS 15-NP)

This sensor is for the electronic measurement of currents: DC, AC, pulsed, mixed, with a galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit). This sensor is flexible and have 3 option selected way for primary current and for this project only need to select to 5 ampere the important is the output voltage is constant and stable. This sensor is use to detect current by using electrical failure signal of Sensor then send to Analog Digital Converter.



Figure 3.1: Hall Effect sensor- LTS 15-NP

3.1.2 Analog to Digital Converter (ADC)

Analog-to-digital converters are among the most widely used devices for data acquisition. Digital computers use binary (discrete) values, but in the physical world everything is analog (continuous). Temperature, pressure (wind or liquid), humidity, and velocity are a few examples of physical quantities that can deal with every day. A physical quantity is converted to electrical (voltage, current) signals using a device called a transducer. Transducers are also referred to as sensors. Although there are sensors for temperature, velocity, pressure, light, and many other natural quantities, they produce an output that is voltage (or current). Therefore, the project needs an analog-to-digital converter to translate the analog signals to digital numbers so that the microcontroller can read them.



Figure 3.2: Analog to Digital Converter (ADC0804)

3.1.3 Microcontroller

The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.



Figure 3.3: Microcontroller (AT89S52)

3.1.4 Relay

A relay SRD-06VDC-SL-C is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. When a current flows through the coil, the resulting magnetic field attracts an armature that is mechanically linked to a moving contact. The movement either makes or breaks a connection with a fixed contact. When the current to the coil is switched off, the armature is returned by a force approximately half as strong as the magnetic force to its relaxed position. Usually this is a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low voltage application, this is to reduce noise. In a high voltage or high current application, this is to reduce arcing. If the coil is energized with DC, a diode is frequently installed across the coil, to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a spike of voltage and might cause damage to circuit components. If the coil is designed to be energized with AC, a small copper ring can be crimped to the end of the solenoid. This "shading ring" creates a small out-of-phase current, which increases the minimum pull on the armature during the AC cycle.



Figure 3.4: Relay (SRD-06VDC-SL-C)

3.1.5 Radio Frequency (RF) module-PCR1A

Radio Frequency is refers to that portion of the electromagnetic spectrum in which electromagnetic waves can be generated by alternating current which is fed to an antenna. Transmitting frequency 315M or 433M, 3-12V voltage and emission current 2-10mA fired power 10mW, 10 frequency stability -5 (Table stable frequency acoustic), -+60 ° C operating temperature range of -40 ° C size 9 × 21 × 5 mm (width × high thick) and the allocation of appropriate MCU

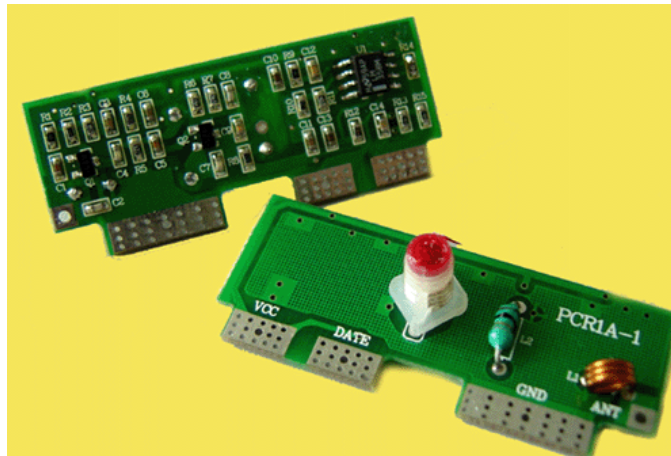


Figure 3.5 : RF module-PCR1A

3.1.6 RS232 standards

To allow compatibility among data communication equipment made by various manufacturers, an interfacing standard called RS232 was set by the Electronics Industries Association (EIA) in 1960. In 1963 it` was modified and called RS232A. RS232B and RS232C were issued in 1965 and 1969, respectively. RS232 is the most widely used serial I/O interfacing standard. This standard is used in PCs and numerous types of equipment. However, since the standard was set long before the advent of the TTL logic family, its input and output voltage levels are not TTL compatible. In RS232, a 1 is represented by -3 to -25 V, while a '0 bit is +3 to +25 V, making -3 to +3 undefined. For this reason, to

connect any RS232 to a microcontroller system we must use voltage converters such as MAX232 to convert the TTL logic levels to the RS232 voltage level.

3.2 Main board

The basic purpose of the main board is to provide the electrical and logical connections by which the other components of the system communicate. A main board is the central or primary circuit board making up a complex electronic system, such as automatic electrical failure detection.

The main board is to analyze the current and control the situation when happen over current. In inside the main board have the analysis circuit and transmitter circuit. Analysis circuit is to detect the current by sensor and send the analog output into analog digital system (ADC) to change the analog signal to digital signal. After change the analog to digital signal the ADC will send the digital output to microcontroller to process the sequences have be program inside the microcontroller. The microcontroller wills analysis the data and check is the current is over 5 ampere or not. If over the current limit (5 ampere), microcontroller will send the signal to relay driver to cut off the channel. In the same time, microcontroller will convert the Binary Code Decimal (BCD) to American Standard Code for Information Interchange (ASCII). After convert the BCD to ASCII then send to transmitter. The transmitter will encode the data first then transmit the data to receiver.

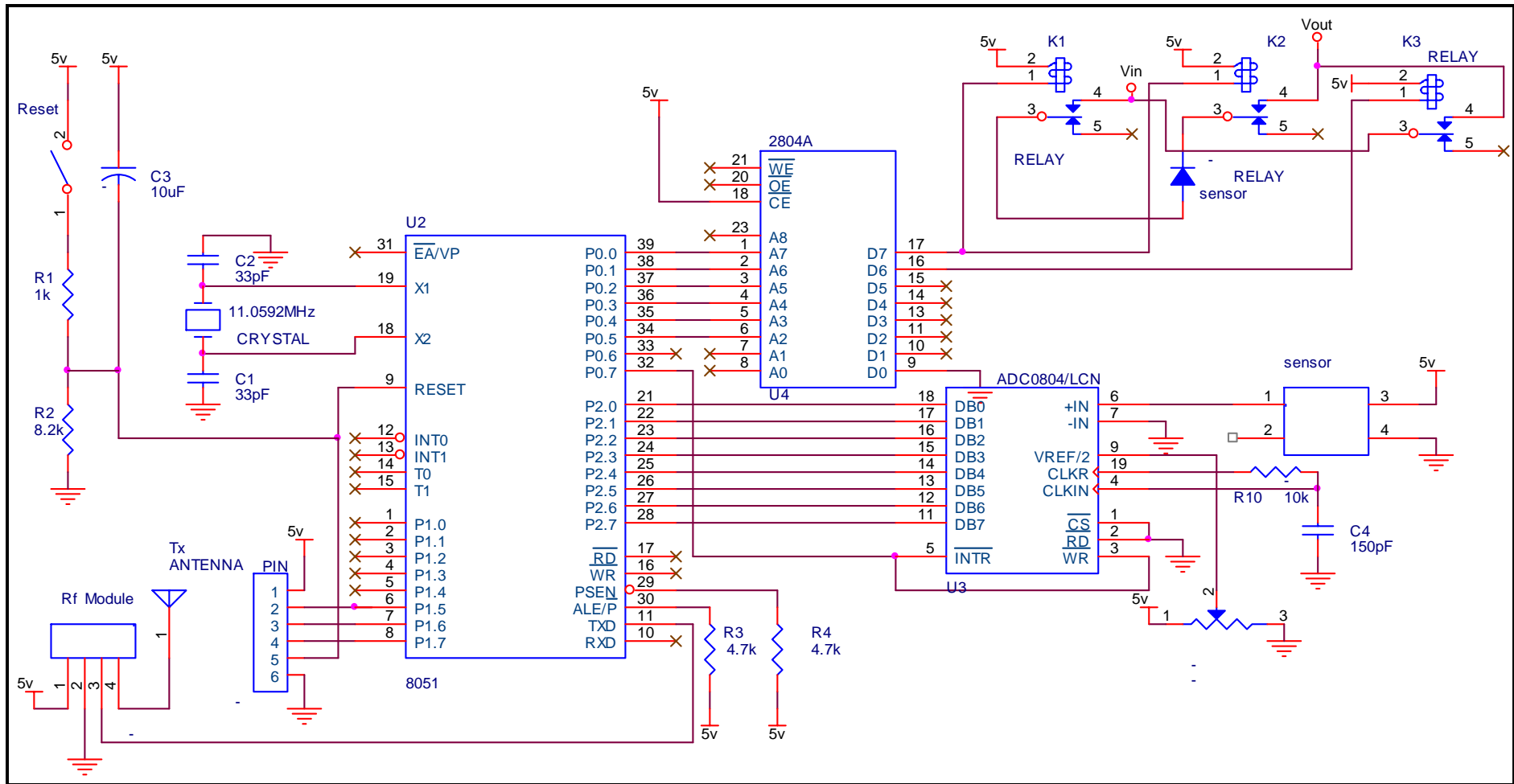


Figure 3.6: Circuit of Main board

3.3 Receiver board

The receiver is the receiving end of a communication channel. It receives decoded messages/information from the sender, who first encoded them. After convert to original data, the data will send into computer by serial port.

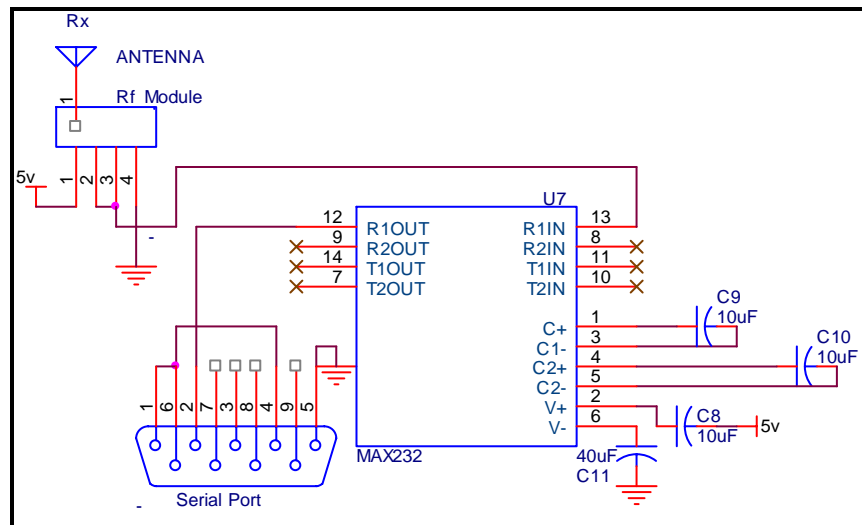


Figure 3.7: Circuit of Receiver board

3.4 Testing

Testing is a process of technical investigation; performances on the circuit have been design and not forget to test the component. Before go to build the circuit on the Printed Board Circuit (PCB), the circuit have to test build on the prototype board and make sure the circuit can operate. This project consists of both hardware and software development so the software programs have to make sure no error because once programs got error the system can not operate as normal as wish. The component testing is also important because the output of the component can cause the result not accurate.

3.4.1 Testing Hall Effect Sensor

This sensor has to find out the reference output before finish the assembly language. Before get the output, have to know the characteristic sensor this sensor is flexible and have 3 option selected way for primary current and for this project only need to select to 5 ampere the important is the output voltage is constant and stable.

Number of primary turns	Primary nominal r.m.s. current I_{PN} [A]	Nominal output voltage V_{OUT} [V]	Primary resistance R_p [m Ω]	Primary insertion inductance L_p [μ H]	Recommended connections
2	± 15	2.5 ± 0.625	0.18	0.013	
	± 7.5	2.5 ± 0.625	0.81	0.05	
3	± 5	2.5 ± 0.625	1.62	0.12	

Figure 3.8: The characteristic of the sensor

The connection of the relay is very important. This system is Automatic Electrical Failure Detection and the current have to be cutoff at 5 ampere so the primary nominal 17 r.m.s current is 5 A and the number of primary turns is 3, and not forget to connect the correct way as recommended connection. Refer to the graph of Output Voltage vs. Primary Current as below is to calculate the current. The graph show the maximum output voltage by sensor is 4.5v is equal to 5 ampere.

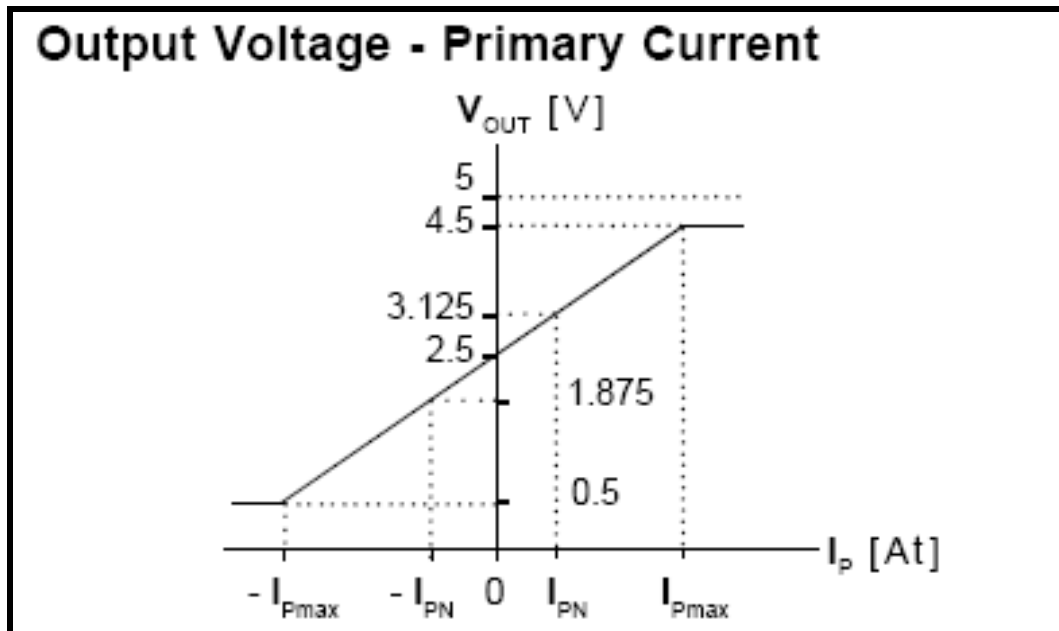


Figure 3.9: The graph of Output Voltage vs. Primary Current

Table 3.0: The Output Voltage and Current data to be measure in the sensor in decimal.

Case	Output Voltage (V)	Current (A)	Decimal
6	4.5	5	230
5	4.1	4	209
4	3.7	3	188
3	3.3	2	168
2	2.9	1	148
1	2.5	0	128

This table as a reference current in output voltage and in decimal, with this way is easy to compare the decimal in assembly language to control the system to cutoff the over current. The calculation to get the decimal value as below:

$$\begin{aligned}\text{Total of voltage range} &= 4.5\text{v} - 2.5\text{ v} \\ &= 2.0\text{v}\end{aligned}$$

$$\begin{aligned}\text{Step voltage in ampere} &= 2\text{v}/5 \\ &= 0.4\text{v}\end{aligned}$$

Case 1: When voltage from 0v up to 2.5v that means the actual current is 0A

Case 2: When voltage from 2.5v up to 2.9v that means the actual current is 1A.

Case 3: When voltage from 2.9v up to 3.3v that means the actual current is 2A.

Case 4: When voltage from 3.3v up to 3.7v that means the actual current is 3A.

Case 5: When voltage from 3.7v up to 4.1v that means the actual current is 4A.

Case 6: When voltage from 4.1v up to 4.5v that means the actual current is 5A.

In Decimal,

$$5A / 255 = 0.019607843mV$$

$$\text{When } 2.5v, \text{ Current} = 0A; 2.5 \times 0.019607843mV = 128$$

$$\text{When } 2.9v, \text{ Current} = 1A; 2.9 \times 0.019607843mV = 148$$

$$\text{When } 3.3v, \text{ Current} = 2A; 3.3 \times 0.019607843mV = 168$$

$$\text{When } 3.7v, \text{ Current} = 3A; 3.7 \times 0.019607843mV = 188$$

$$\text{When } 4.1v, \text{ Current} = 4A; 4.1 \times 0.019607843mV = 209$$

$$\text{When } 4.5v, \text{ Current} = 5A; 4.5 \times 0.019607843mV = 230$$

Table below is the testing result by use the variable resistor to set the reference voltage. The current output voltage is measure when have load. The testing result is in expected because when the output voltage achieve to 4.50V the system was cut off the channel source.

Table 3.1: Result of current measurement output voltage

Current (A)	Actual output voltage (V)	Current output voltage (V)
5	4.5	4.50
4	4.1	4.11
3	3.7	3.69
2	3.3	3.29
1	2.9	2.92
0	2.5	2.50

3.5 Software

Software, consisting of programs, enables a computer to perform specific tasks, as opposed to the physical components of the system (hardware). This includes application software such as a word processor, which enables a user to perform a task, and system software such as an operating system, which enables other software to run properly, by interfacing with hardware and with other software or custom software made to user specifications.

3.5.1 Programming Language

An assembly language is a low-level language used in the writing of computer programs. Assembly language uses mnemonics, abbreviations or words that make it easier to remember a complex instruction and make programming in assembler an easier task. The goal of using mnemonics in the writing of assembly language programs is to replace the more error prone, and time consuming, effort of directly programming in a target computer's numeric machine code that had been used with the very first computers. An assembly language program is translated into the target computer's machine code by a utility program called an assembler. Translators that take an entire program and translate it as a body are called compilers. Translators that take one line at a time are called interpreters. Translators that translate assembly language programs into machine language are called assemblers.

Assembly language programs are tightly coupled with (and specific to) a target computer architecture – as opposed to higher-level programming languages, which are generally platform-independent. More sophisticated assemblers extend the basic translation of program instructions with mechanisms to facilitate program development, control the assembly process, and aid debugging.

Assembly language was once widely used for all aspects of programming, but today it tends to be used more narrowly, primarily when direct hardware manipulation or unusual

performance issues are involved. Typical uses are device drivers, low-level embedded systems, and real-time systems. These applications benefit from the increased speed of processing assembly program instructions.

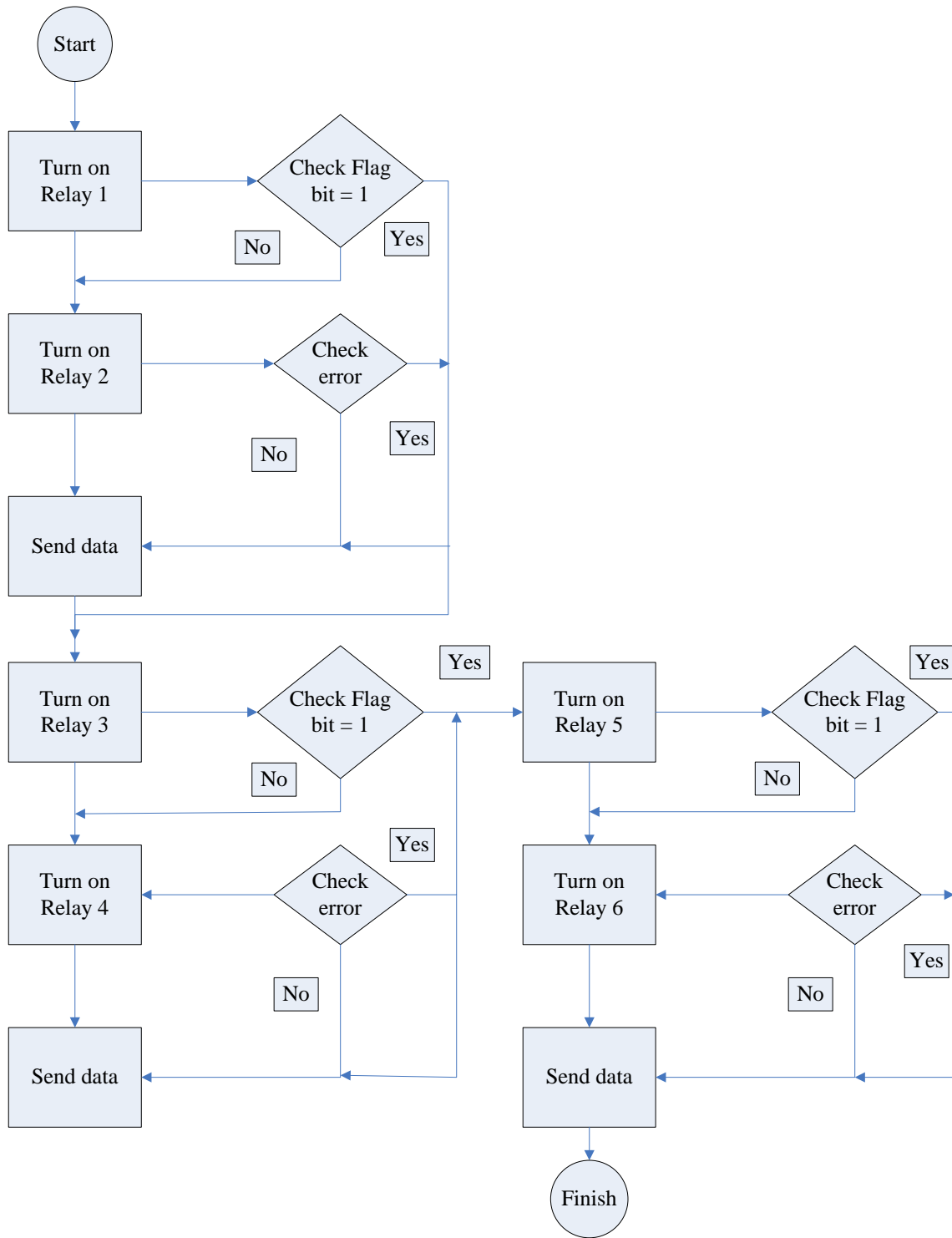


Figure 3.10: Flow chart of operation system.

3.5.2 Operation of the system

From the flow chart it can see clearly how the system going operation by using assembly language to write the program. The system starting will turn on the Relay, in this system got 6 relay to control 3 channel; Channel 1, Channel 2, and Channel 3. Channel 1 is control by Relay 1 and Relay 2. Channel 2 is control by Relay 3 and Relay 4 and Channel 3 is control by Relay 5 and Relay 6. First will going to turn on Relay 1 and check flag bit if got flag bit the process will direct go to turn on channel 2. If no flat bit then will go to turn on Relay 2 and check the data from sensor got error or not with compare the Binary Code in Decimal (BCD) if over than 230 that means is error, if no have error the data will be send out to computer. If error detect, it will send the data to computer and cutoff the channel. Follow by another 2 channel is going to process the same step sequence. (Refer to Appendix A)

Table 3.2: Operation of the system

	Decimal	Result	Action
Channel 1	< 230	No Error	No action
Channel 1	>230	Error	Cutoff Channel 1
Channel 2	< 230	No Error	No action
Channel 2	>230	Error	Cutoff Channel 2
Channel 3	< 230	No Error	No action
Channel 3	>230	Error	Cutoff Channel 3

3.5.3 Data transfer rate

The rate of data transfer in serial data communication is stated in *bps* (bits per second). Another widely used terminology for bps is *baud rate*. However, the baud and bps rates are not necessarily equal. This is due to the fact that baud rate is the modem terminology and is defined as the number of signal changes per second. In modems, there are occasions when a single change of signal transfers several bits of data. As far as the conductor wire is concerned, the baud rate and bps are the same, and for this reason in this project use the terms bps and baud interchangeably.

The data transfer rate of a given computer system depends on communication ports incorporated into that system. For example, the early IBM PC/XT could transfer data at the rate of 100 to 9600 bps. However in recent years, Pentium based PCs transfer data at rates as high as 56K bps. It must be noted that in asynchronous serial data communication, the baud rate is generally limited to 100,000 bps.

3.5.4 Baud rate in the AT89S52

The AT89S52 transfers and receives data serially at many different baud rates. The baud rate in the AT89S52 is programmable. This is done with the help of timer 1. Before we discuss how to do that, we will look at the relationship between the crystal frequency and the baud rate in the AT89S52.

The 8052 divides the crystal frequency by 12 to get the machine cycle frequency. In the case of XTAL = 11.0592 MHz, the machine cycle frequency is 921.6 kHz (11.0592 MHz / 12 = 921.6 kHz). The 8051's serial communication UART circuitry divides the machine cycle frequency of 921.6 kHz by 32 once more before it is used by timer 1 to set the baud rate. Therefore, 921.6 kHz divided by 32 gives 28,800 Hz. This is the number we will use throughout this section to find the timer 1 value to set the baud rate. When timer I

is used to set the baud rate it must be programmed in mode 2, which is 8-bit, auto-reload. To get baud rate compatible with PC, we must load TH1 with the calculation as below. With XTAL = 11.0592 MHz, the TH1 value needed to have the 300 baud rates to operating the system. Below program is showing the coding of the above step.

```
mov tmod,#20h      ; timer1, mode 2 (auto reload)
mov th1,#0a0h     ; 300 baud
mov scon,#50h     ; 8-bit, 1 stop, REN enable
setb tr1          ; start timer 1
```

Program to send the message "ZCEY1" serially at 300 baud, 8-bit data,

```
mov tmod,#20h      ; timer1, mode 2 (auto reload)
mov th1,#0a0h     ; 300 baud
mov scon,#50h     ; 8-bit, 1 stop, REN enable
setb tr1          ; start timer 1
mov a,#"Z"        ; send "Z"
acall send
mov a,#"C"        ; send "C"
acall send
mov a,#"E"        ; send "E"
acall send
mov a,#"Y"        ; send "Y"
acall send
mov a,#"1"        ; send "1"
```

3.6 Serial Communication

When a microprocessor communicates with the outside world, it provides the data in byte-sized chunks. In some cases, such as printers, the information is simply grabbed from the 8-bit data bus and presented to the 8-bit data bus of the printer. This can work only if the cable is not too long, since long cables diminish and even distort signals. Furthermore, an 8-bit data path is expensive. For these reasons, serial communication is used for transferring data between two systems located at distances of hundreds of feet to millions of miles apart.

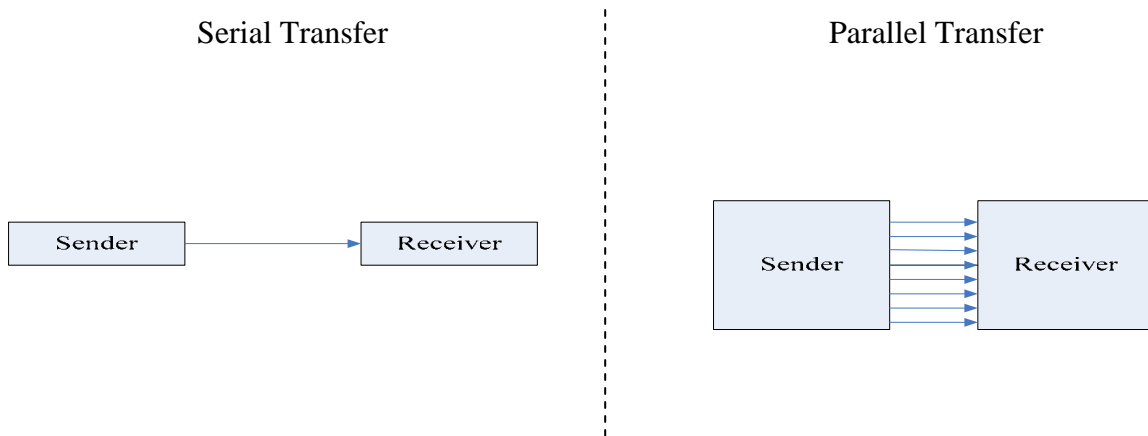


Figure 3.11: Serial and Parallel Data Transfer

The fact that in serial communication a single data line is used instead of the 8-bit data line of parallel communication makes it not only much cheaper but also makes it possible for two computers located in two different cities to communicate over the telephone. For serial data communication to work, the byte of data must be converted to serial bits using a parallel-in-serial-out shift register; then it can be transmitted over a single data line. This also means that at the receiving end there must be a serial-in-parallel-out shift register to receive the serial data and pack them into a byte.

Serial data communication uses two methods, asynchronous and synchronous. The synchronous method transfers a block of data (characters) at a time while the asynchronous transfers a single byte at a time. It is possible to write software to use either of these methods, but the programs can be tedious and long. For this reason, there are special IC chips made by many manufacturers for serial data communications. These chips are commonly referred to as UART (universal asynchronous receiver-transmitter) and USART (universal synchronous-asynchronous receiver-transmitter). The 8051 chip has a built-in UART.

3.7. Printed Circuit Board (PCB)

In electronics, printed circuit boards, or PCBs, are used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive substrate. Alternative names are printed wiring board (PWB), and etched wiring board. Populating the board with electronic components forms a printed circuit assembly (PCA), also known as a printed circuit board assembly (PCBA).

PCBs are rugged, inexpensive, and can be highly reliable. They require much more layout effort and higher initial cost than either wire-wrapped or point-to-point constructed circuits, but are much cheaper, faster, and consistent in high volume production. Below is the process flow for producing a PCB.

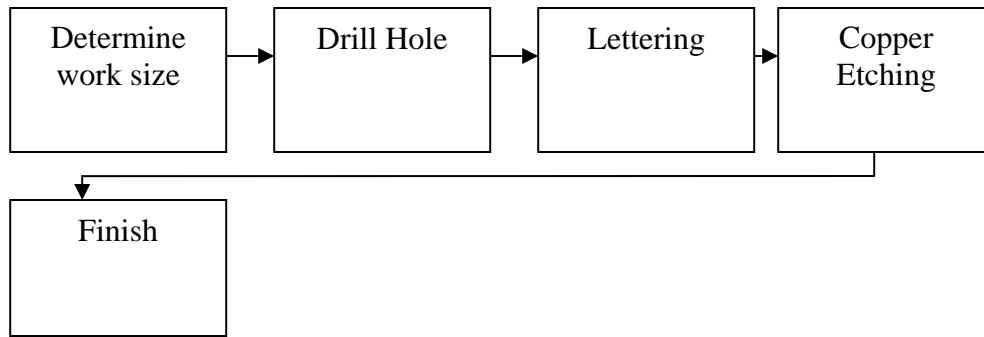


Figure3.12: Process flow for producing a PCB

Determine work size is means to figure out how bigger size going to design on the PCB and the chassis to fit it on. After desired the size PCB going to use, the second step is drill hole and littering the schematic on the PCB. After done the lettering, the following process is copper etching. Etching is the process of using strong acid to cut into the unprotected parts of a metal surface to create a design in intaglio in the metal (the original process - in modern manufacturing other chemicals may be used on other types of material). As an intaglio method of printmaking, it is, along with engraving, the most important technique for old master prints, and remains widely used today. Below picture is main board of the project.

3.7.1 Receiver Board

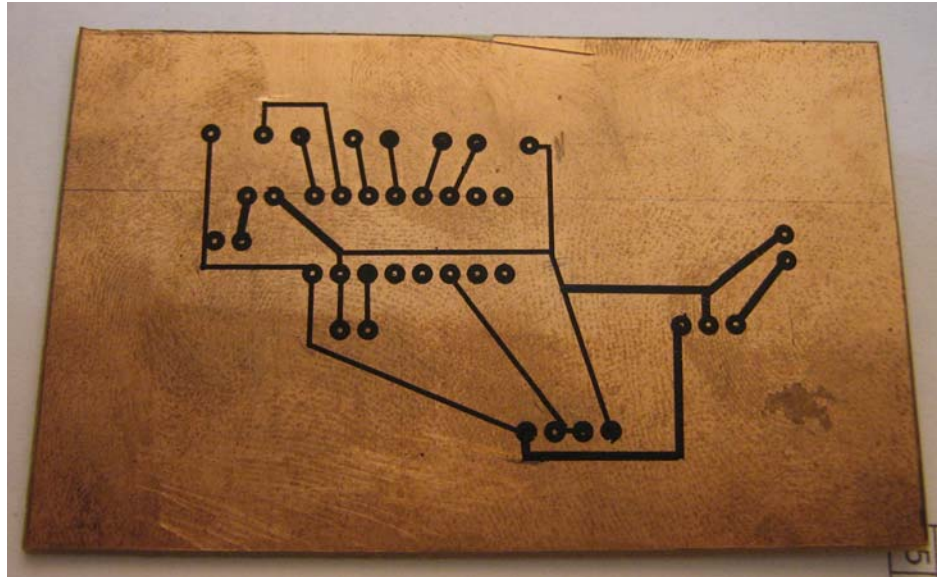


Figure 3.13: After Lettering

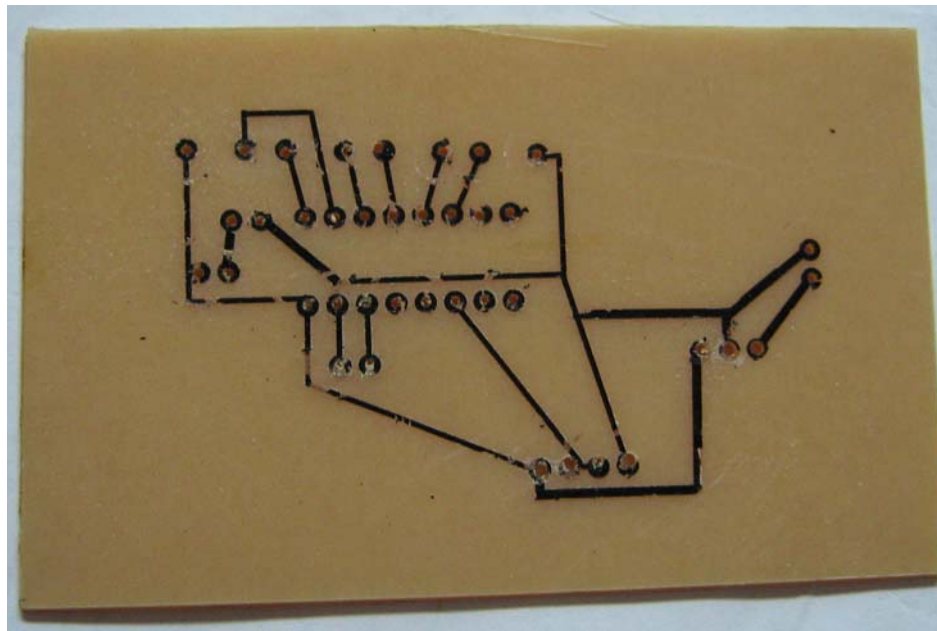


Figure 3.14: After Etching

3.7.2 Main Board

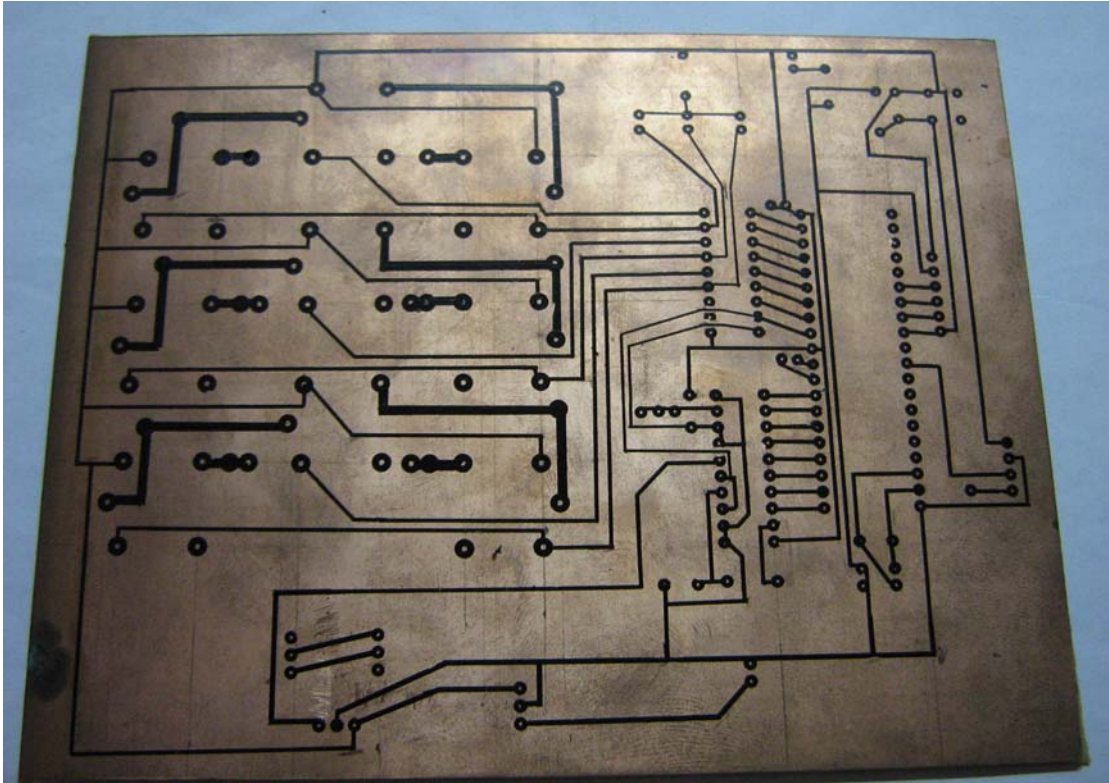


Figure 3.15: After Lettering

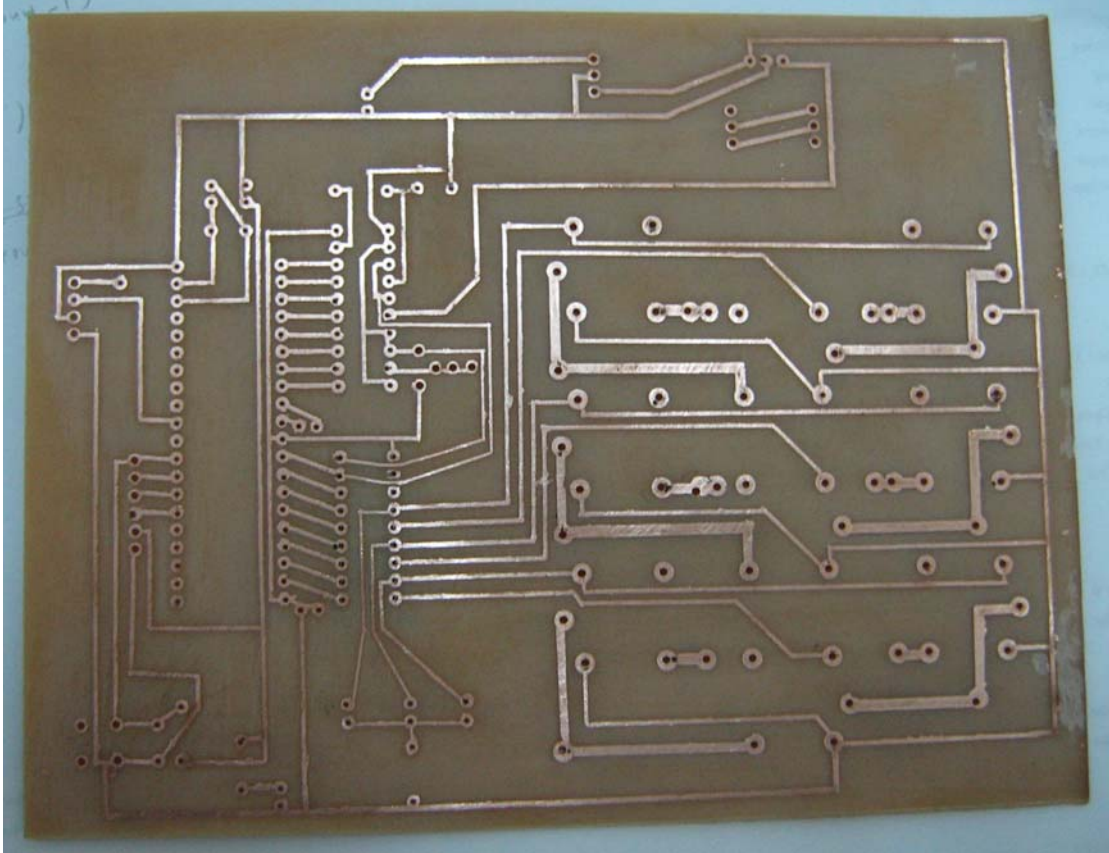


Figure 3.16: After Etching

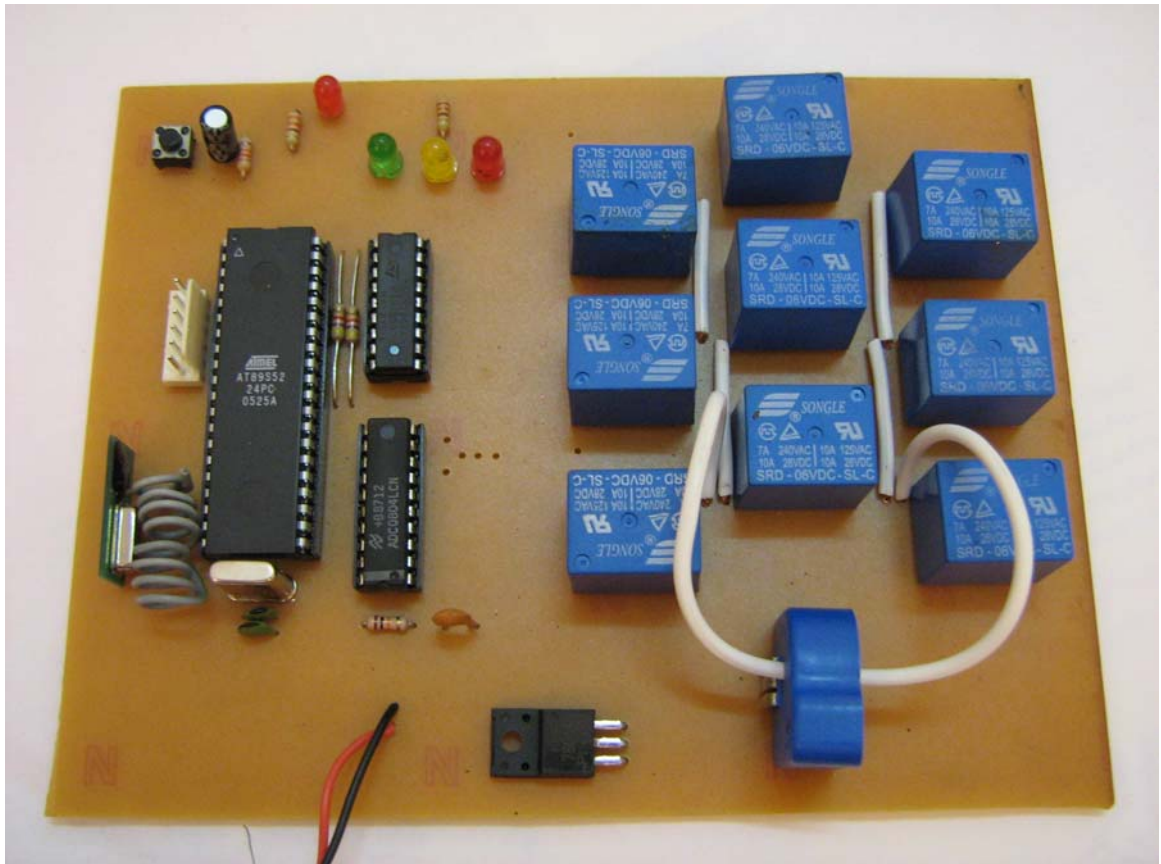


Figure 3.17: After solder component (Main Board)



Figure 3.18: After solder component (Receiver board)